WATER RESOURCES REVIEW for

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

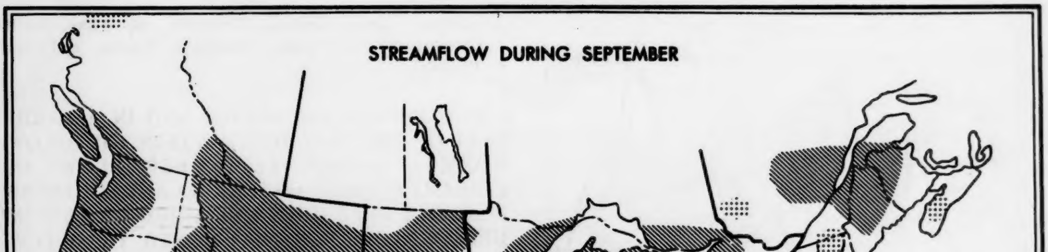
CANADA
DEPARTMENT OF THE ENVIRONMENT
WATER RESOURCES BRANCH

SEPTEMBER
1972

STREAMFLOW AND GROUND-WATER CONDITIONS

Streamflow decreased seasonally in most of southern Canada and in much of the United States. Principal exceptions were increased flows in the Maritime Provinces and southern Ontario in Canada, and in several parts of the Western Great Lakes region, and in New Mexico and Texas. Locally intense summer storms caused a recurrence of severe flooding in Iowa and in the urban areas of Duluth, Minnesota and Chicago, Illinois. Flooding occurred also in parts of Missouri, Kansas, Texas, New Mexico, Michigan, Ohio, Wisconsin, and Virginia.

Below-normal streamflow persisted in much of the Southern one third of the Southeast and in southeastern Oklahoma, western Arkansas, northern California, and central Arizona, as well as in parts of Oahu and Maui islands in Hawaii. Contrasting with these low flows were large areas of above-normal streamflow across the northern half of the United States, and smaller areas scattered throughout the South and West.



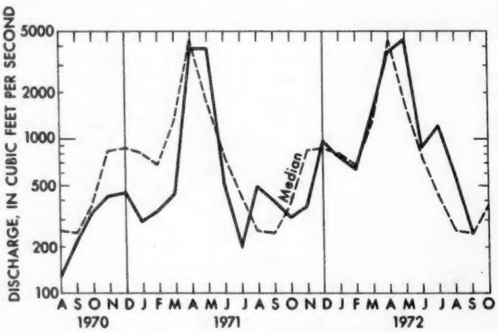
NORTHEAST

[Atlantic Provinces and Quebec; Delaware, Maryland, New York, New Jersey, Pennsylvania, and the New England States]

STREAMFLOW GENERALLY DECREASED SEASONALLY AND WAS WITHIN THE NORMAL RANGE IN MOST OF THE REGION. HOWEVER, ABOVE-NORMAL PRECIPITATION CAUSED RISES IN STREAMFLOW IN NEW BRUNSWICK, NORTHERN CAPE BRETON ISLAND (NOVA SCOTIA), NORTHEASTERN QUEBEC, RHODE ISLAND, AND SOUTHEASTERN MASSACHUSETTS.

In Nova Scotia, an unusually heavy rain on the 10th in the northern part of Cape Breton Island, produced a daily discharge on the Northeast Margaree River at Margaree Valley (drainage area, 142 square miles) of 5,000 cfs on the 11th, highest daily flow for September in the 57 years of record. The mean flow for the month as a whole, however, was 479 cfs—within the normal range for the month.

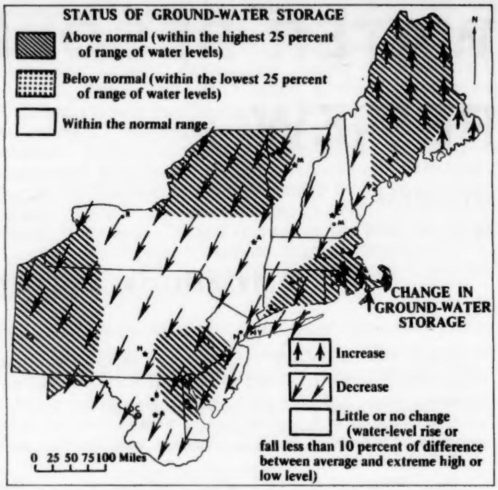
Flows in most of the Northeast were normal for September, an example being the discharge of White River at West Hartford in south-central Vermont (see graph). Above-normal flows occurred in parts of Maine and Quebec and a few other areas, including south-central Maryland where the monthly discharge of Seneca Creek at Dawsonville was in the above-normal range for the 14th consecutive month.



Monthly mean discharge of White River at West Hartford, Vt. (Drainage area, 690 square miles.)

As the water year came to a close at the end of September, flows of most streams in the Northeast were in the normal range (see map on page 3); the principal exceptions were southern New England where flows were above normal and southern Nova Scotia where flows were below normal.

Ground-water levels declined in the northeastern States except for rises in much of Maine and in southeastern Massachusetts (see map). Monthend levels remained above normal in more than half of the region, largely a carryover from high levels of preceding months.



Map above shows ground-water storage near end of September and change in ground-water storage from end of August to end of September.

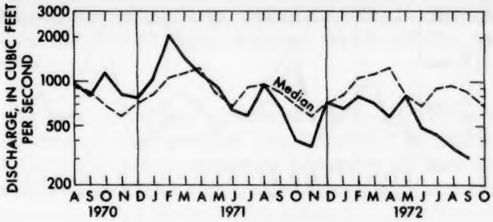
SOUTHEAST

[Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia]

STREAMFLOW DECREASED AND IN A LARGE PART OF THE DEEP SOUTH WAS IN THE BELOW-NORMAL RANGE. SEPTEMBER FLOWS OF STREAMS IN PARTS OF FLORIDA AND SOUTHERN ALABAMA WERE ONLY ONE THIRD OR LESS OF MEDIAN FLOWS FOR THAT MONTH. THESE LOW-FLOW CONDITIONS WERE IN CONTRAST TO ABOVE-NORMAL FLOWS IN SOUTHWESTERN FLORIDA (MYAKKA RIVER) AND FLASH FLOODING THAT OCCURRED IN EASTERN VIRGINIA AS A RESULT OF HEAVY RAINS NEAR END OF MONTH.

In south-central Florida, daily discharge of Peace River at Arcadia (drainage area, 1,370 square miles), was 218 cfs on the 22d, lowest daily discharge for September in the 42 years of record. In the State's western panhandle, daily discharge of Shoal River near Crestview was 248 cfs on the 21st, alltime lowest daily discharge (for any month) in the 35 years of record; monthly discharge decreased for the 4th consecutive month (see graph). In adjacent southern Alabama, monthly mean discharge of Conecuh River at Brantley (drainage area, 492 square miles) was 33 cfs, or 16 percent of the September median.

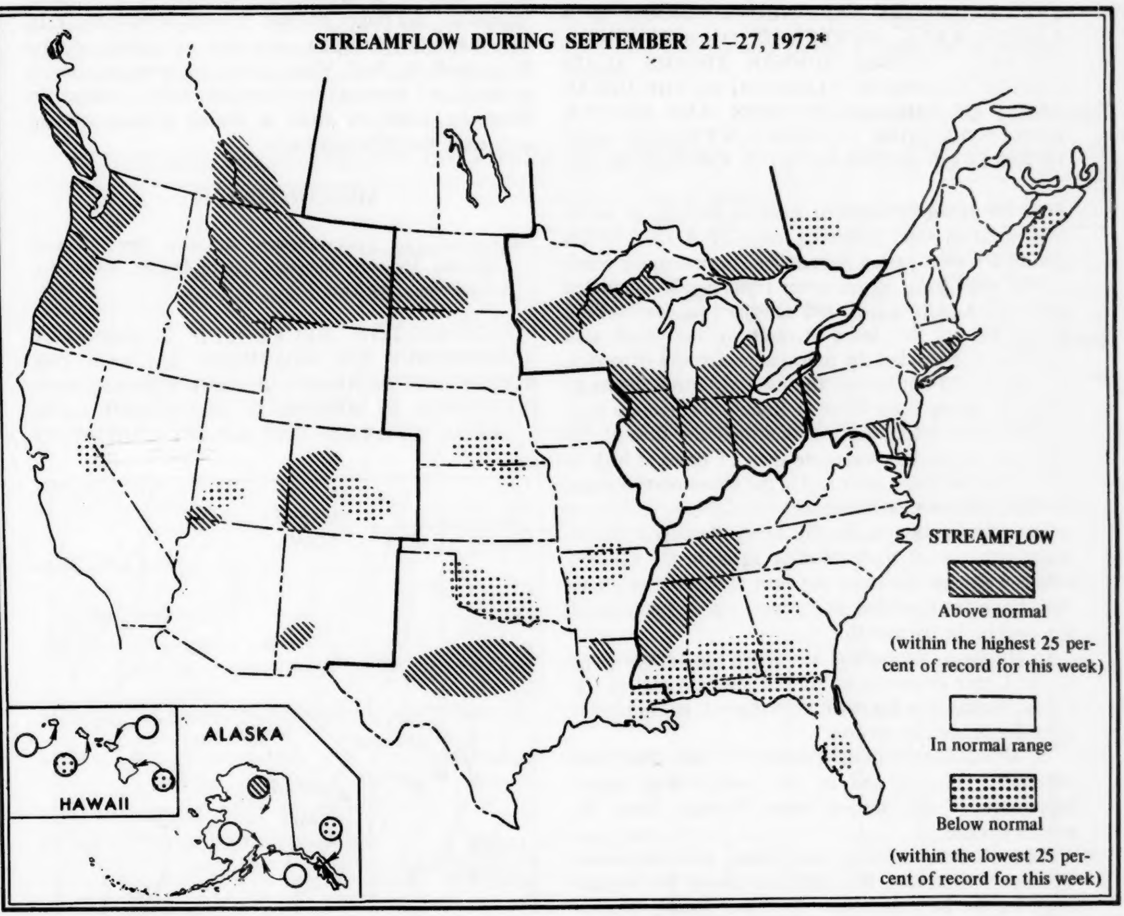
Flow of Silver Springs in north-central Florida increased slightly, to 750 cfs, 87 percent of normal. In the southeastern part of the State, flow southward through the Tamiami Canal outlets, 40-mile bend to Monroe,



Monthly mean discharge of Shoal River near Crestview, Fla. (Drainage area, 474 square miles.)

increased 225 cfs, to 348 cfs, 75 percent of normal. Flow of Miami Canal decreased 17 cfs, to 335 cfs, 84 percent of normal.

Ground-water levels declined seasonally in most of the region; exceptions included rises in the shallow limestone aquifers of central Kentucky due to recharge from heavy rains. In Georgia, levels remained about the same in the Brunswick area and rose slightly in the Savannah area. In central Mississippi in the heavily pumped Sparta Sand, levels declined rather sharply, reaching record-low stages in some wells. Monthend levels were generally



*Streamflow compared with that occurring during the same 7 days of September of the 30-year reference period 1941–70. These 7 days of September indicate streamflow conditions near the close of the water year, ending September 30.

Other maps in this issue show streamflow conditions for September as a whole (front page), for the water year as a whole—October 1 through September 30 (top of page 9), and for the last half of the water year (bottom of page 9). Each of these maps compares conditions of the past 1, 12, or 6 months, respectively, with conditions of the same time of the year during a 30-year reference period.

above average in Kentucky; slightly above average in North Carolina (except in heavily pumped Coastal Plain in the east); near or below average in most of West Virginia; and below average in northern and southeastern Florida.

WESTERN GREAT LAKES REGION

[Ontario; Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin]

STREAMFLOW INCREASED IN ILLINOIS AND DECREASED IN MINNESOTA; IN EACH OF THE OTHER STATES AND IN ONTARIO, FLOWS OF SOME STREAMS DECREASED AND SOME INCREASED. FLOWS WERE ABOVE NORMAL IN A LARGE AREA CENTERED ON WISCONSIN. LOCALLY INTENSE SUMMER STORMS AGAIN CAUSED EXTENSIVE FLOODING IN THE URBAN AREAS OF CHICAGO, ILLINOIS, AND DULUTH, MINNESOTA. SOME FLOODING OCCURRED ALSO IN PARTS OF MICHIGAN, OHIO, AND WISCONSIN.

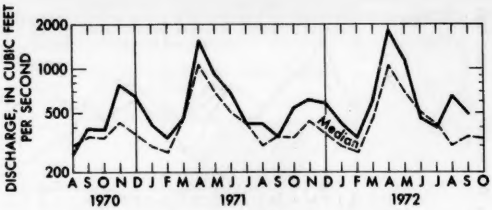
Severe flooding occurred again in Duluth, in northeastern Minnesota, following rains of 4 to 5 inches during a 6-hour period September 20, destroying much of the emergency storm sewer repair work completed since the August floods, and causing two deaths. Peak discharges on five small streams in the flood area equalled or exceeded the previous maximums of record. In east-central Minnesota, the monthly mean discharge of 1,168 cfs on Crow River at Rockford (drainage area, 2,520 square miles) was less than half the flow of the previous month, but was more than 11 times as high as the median for September and in the above-normal range for the 24th consecutive month.

In northern Illinois, locally heavy thunderstorms at midmonth caused flash flooding again in the Chicago area and sharply increased the flow of Pecatonica River. Monthly mean discharge at Freeport was 351 percent of the median for the month.

In Michigan, streamflow was above the normal range in the Upper Peninsula and in the southern part of the Lower Peninsula as the result of persistent, but moderate rains throughout the month.

In Ohio, heavy thunderstorms in the northwest September 13–14, and in the north-central region September 17–18, caused some flooding along the smaller streams.

Flow of Oconto River near Gillett, in northeastern Wisconsin, decreased but remained above the normal range for the 2d consecutive month (see graph). By contrast, the monthly mean flow of Jump River at Sheldon, in the northwest corner of the State, was nearly double that of August and was 1,000 percent of the September median. Moderate flooding occurred in many areas, resulting from frequently recurring rains of from 1 to 5 inches.



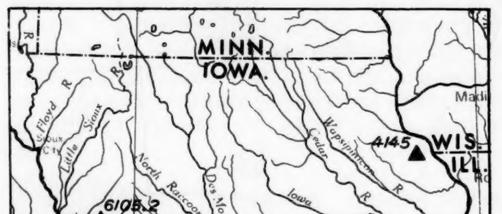
Monthly mean discharge of Oconto River near Gillett, Wis. (Drainage area, 678 square miles.)

Ground-water levels declined in most of the region but generally rose in Wisconsin. Monthend levels were above average in Michigan, Wisconsin, and northern Minnesota; and below average in southern Minnesota. In the heavily pumped artesian aquifers of the Minneapolis-St. Paul, Minn., area, levels rose as a result of decreased pumping but remained below average. In Wisconsin, levels continued to decline in deep artesian aquifers in the Milwaukee area.

MIDCONTINENT

[Manitoba and Saskatchewan; Arkansas, Iowa, Kansas, Louisiana, Missouri, Nebraska, North Dakota, Oklahoma, South Dakota, and Texas]

STREAMFLOW DECREASED SEASONALLY THROUGHOUT THE NORTHERN HALF OF THE REGION, BUT INCREASED IN SOME STREAMS AND DECREASED IN OTHERS IN THE SOUTH. LATE SUMMER STORMS CAUSED FLOODING IN



Location of stream-gaging stations in Iowa described in table of peak stages and discharges.

WESTERN AND NORTHEASTERN IOWA, NORTHWESTERN MISSOURI, WEST-CENTRAL TEXAS, AND IN SCATTERED BASINS OVER MUCH OF KANSAS.

In west-central and southwestern Iowa, severe flooding resulted from excessive rainfall, totaling as much as 21 inches in a 50-hour period September 10 to 12 in northwestern Shelby County, and averaging 10 inches or more over all of Shelby and Audubon Counties. Hardest hit were the upper basins of East and West Nishnabotna Rivers. Two lives were lost, about 110,000 acres of cropland were inundated, and crop damage was estimated at about $10 million. Thirty bridges were damaged and total damage to roads and bridges was estimated at $4.5 million. Other damage was estimated at about $0.5 million. Twelve counties were declared disaster areas. Gaging stations on East Nishnabotna River at Red Oak and Nodaway River at Clarinda, each with 42 years of record, indicated this flood to be the greatest since 1947. The flood peaks were attenuated as they moved downstream but monthly mean discharge of Nishnabotna River above Hamburg was the largest for September in 45 years of record. Severe flooding occurred again in Little Maquoketa and North Fork Maquoketa River basins in northeastern Iowa September 13 as the result of 5 inches of rain in 6 hours in the northern half of Dubuque County. These basins were flooded early in August. The peak discharges of several of the streams in the Iowa flood areas were greater than those likely to occur on the average of only once in 100 years (see accompanying table of peak stages and discharges).

In northwestern Missouri, moderate flooding occurred in the Nodaway, Platte, and Grand River basins September 12–15. Monthly mean discharge of Grand River near Gallatin was almost 6 times the September median.

Provisional data; subject to revision

STAGES AND DISCHARGES FOR THE FLOODS OF SEPTEMBER AT SELECTED SITES IN IOWA

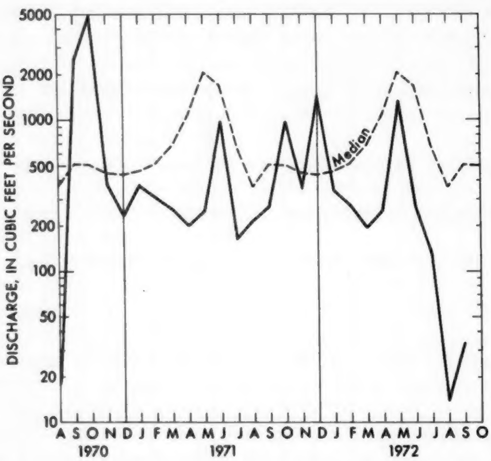
WRD station number	Stream and place of determination	Drainage area (square miles)	Period of known floods	Maximum flood previously known			Maximum during present flood				
				Date	Stage (feet)	Discharge (cfs)	Date	Stage (feet)	Discharge		Recurrence interval (years)
									Cfs	Cfs per square mile	
LITTLE MAQUOKETA RIVER BASIN											
5–4145	Little Maquoketa River near Durango.	130	1925, 1934–72	Aug. 2, 1972	23.13	40,000	Sept. 13	21.76	23,200	178	[a]1.8
BOYER RIVER BASIN											
6–6095	Boyer River at Logan	871	1918–25, 1937–72	Feb. 19, 1971	22.65	25,000	11	21.90	23,500	27.0	30
MOSQUITO CREEK BASIN											
6–6105.2	Mosquito Creek near Earling.	32.0	1965–72	June 15, 1967	24.42	2,960	11	31.18	[b]15,000	469	[a]2
NISHNABOTNA RIVER BASIN											
6–8074.1	West Nishnabotna River at Hancock.	609	1959–72	Mar. 1, 1965	[c]20.44	18,000	13	22.14	24,000	39.4	75
6–8092.1	East Nishnabotna River near Atlantic.	436	1960–72	[d]Mar. 1, 1965	20.43	20,500	12	22.8	26,000	59.6	[a]1.1
6–8095	East Nishnabotna River at Red Oak.	894	1918–25, 1936–72	June 17, 1947	28.23	36,200	13	27.40	35,000	39.1	[a]1.1
NODAWAY RIVER BASIN											
6–8170	Nodaway River at Clarinda	762	1903, 1918–25, 1936–72	August 1903 June 13, 1947	25.4 25.3	(e) 31,100	13	19.45	25,500	33.5	50
GRAND RIVER BASIN											
6–8979.5	Elk Creek near Decatur City.	52.5	1959, 1967–72	Aug. 6, 1959 June 14, 1967	22.0 18.35	(e) 15,000	13	18.0	14,000	267	[a]1.7

[a] Approximate ratio of discharge to that of 100-year flood.
[b] Estimated.
[c] Affected by backwater from ice.
[d] Site and datum then in use.
[e] Not determined.

Moderate flood crests occurred also on some streams in Texas as a result of local thunderstorms but damages were minimal. Flows increased sharply in streams in the southern part of the State, below San Antonio along the lower Gulf Coast, and in the area west and northwest of San Angelo in the upper Colorado, upper Brazos, and North Concho River basins. Monthly mean discharge of North Concho River near Carlsbad was about 17 times the September median.

In central Kansas, considerable flooding of croplands occurred September 1–2 along the lower Smoky Hill River and its tributaries as a result of rains of up to 6 inches. In northwest Kansas, flooding occurred along Prairie Dog Creek September 5–6 and a peak discharge of about 10,000 cfs was recorded at the gaging station above Norton Reservoir (highest since the station was established in 1962). The same storm shifted to northeast Kansas on the 6th where 5 to 7 inches of rain resulted in a peak discharge on Rock Creek near Louisville of about 17,000 cfs, highest since 1968. Damage was estimated at $115,000. This storm also resulted in flooding along Mud Creek in and near Lawrence, causing damage to businesses and crops in excess of $100,000, and in Stranger Creek basin, where damages of about $65,000 occurred in the town of Easton. In southeast Kansas, considerable flooding of residential areas occurred in Coffeyville September 26 as a result of more than 5 inches of rain.

In Oklahoma, streamflow conditions improved in the western half of the State but remained near drought levels in the east. Monthly mean discharge of Washita River near Durwood increased seasonally but was only 7 percent of the September median and in the below-normal range for the 4th consecutive month (see graph).



Monthly mean discharge of Washita River near Durwood, Okla. (Drainage area, 7,202 square miles.)

Cumulative runoff at this station was only 24 percent of median for the period April through September.

In North Dakota, high carryover flows from August resulted in monthly mean discharges above the normal range in the south, and heavy rains during the month increased flows in northern streams. The first snow of the season fell on the 25th, with depths of as much as 8 inches in the west-central part of the State.

In northern Arkansas, flow of Buffalo River near St. Joe continued in the below-normal range for the 5th consecutive month, but runoff from rain showers in the south increased the flow of Saline River near Rye into the normal range for the first month since February. Cumulative runoff at this station for the last six months of the water year was only 16 percent of median, and that for the entire water year was only 28 percent of median.

In Louisiana, monthly mean discharge of Calcasieu River near Oberlin decreased sharply, from 100 percent of median in August to 40 percent in September, and although scattered thunderstorms occurred throughout the State, most streams were at low base flow at monthend.

The level of Lake Winnipeg at Gimli, Manitoba, averaged 714.81 feet above mean sea level, 1.07 feet above the long-term mean for September.

Ground-water levels generally declined except in areas receiving recharge from locally heavy rains, especially in parts of Iowa and Kansas, causing levels to rise. Monthend levels remained near average in North Dakota and were near or above average in Iowa. In the rice-growing area of east-central Arkansas, water levels in the shallow aquifer (Quaternary deposits) remained about the same and was about average for end of September 1963–72; water level in the deep aquifer (Sparta Sand) rose seasonally but was at a new low for the month. In the industrial aquifer of central and south Arkansas (Sparta Sand), the level in the key well at Pine Bluff was unchanged but was lowest of record for the month. In southwestern Louisiana, water level in the key well in the Chicot aquifer rose about 4 feet but was lowest for September in the 31 years of record. In Texas, levels rose in the Edwards Limestone at San Antonio; and fell in the Edwards Limestone at Austin, in the Evangeline aquifer at Houston, and in the bolson deposits at El Paso. Monthend levels were above average at Austin and San Antonio, and below-average at El Paso and Houston.

WEST

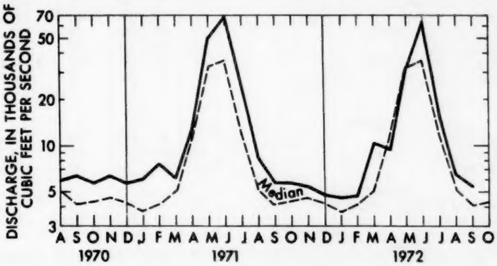
[Alberta and British Columbia; Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming]

STREAMFLOW CONTINUED TO DECREASE SEASONALLY IN MUCH OF THE REGION BUT WAS IN OR ABOVE THE NORMAL RANGE IN PARTS OF EACH STATE AND PROVINCE AND INCREASED IN MANY BASINS AS A RESULT OF LOCALIZED RAINS. FLASH FLOODING OCCURRED IN SOUTHWEST NEW MEXICO. FLOWS CONTINUED BELOW

THE NORMAL RANGE IN THE NORTH COASTAL AREA OF CALIFORNIA AND IN EAST-CENTRAL ARIZONA.

In Washington, heavy rains on September 7, and again September 21–22, resulted in sharp increases in streamflow in low-elevation basins. Streams having headwaters in the higher elevations continued to flow in the above-normal range as a result of melting snowpack and the late September storm. Monthly mean flow of Skyomish River near Gold Bar was above the normal range for the 5th consecutive month.

In central and southeastern Idaho, flow of Salmon River at White Bird and Snake River near Heise continued in the above-normal range. Monthly mean flow at White Bird has been less than the median in only one month since September 1969 (see graph). September



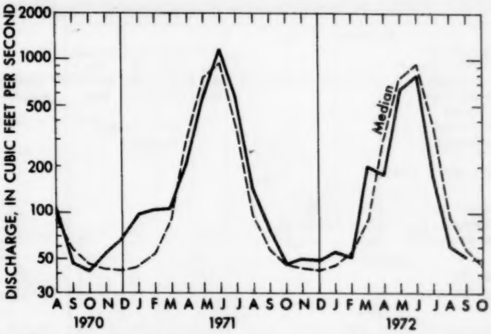
Monthly mean discharge of Salmon River at White Bird, Idaho (Drainage area, 13,550 square miles.)

flow in Boise River basin, in the southwest, was the fifth highest in 78 years of record. In most basins of the State, cumulative runoff during the 1971–72 biennium ending September 30, 1972, was considerably higher than for any previous biennium of record.

In Montana, streamflow continued above the normal range throughout the State, decreasing seasonally in the west but increasing in the east as a result of thundershower activity and the corresponding decrease in use of streamflow for irrigation.

In southwestern Utah, monthly mean flow of Beaver River near Beaver was below the normal range for the 6th consecutive month, resulting in cumulative runoff during that period of only 28 percent of median. In northern Utah, level of Great Salt Lake declined 0.20 foot during the month (to 4,198.00 feet above mean sea level), 1.05 feet higher than a year ago.

In the southern end of the Sierra Nevada of California, heavy rains in the upper reaches of Kings River resulted in highest daily mean discharge (2,030 cfs on the 6th) in 42 years of record at the index stream-gaging station above North Fork (drainage area, 952 square miles). Roughly 120 miles to the north, flow of West Walker River below Little Walker River near Coleville, decreased seasonally and was below the median for the 6th consecutive month (see graph). In southern California, forest fires burned approximately 22 percent of the Sespe-Fillmore drainage area in Ventura County.



Monthly mean discharge of West Walker River below Little Walker River near Coleville, Calif. (Drainage area, 180 square miles.)

In southwestern New Mexico, a severe flash flood occurred September 2 on Percha Creek, a small tributary of the Rio Grande just downstream from Caballo Reservoir and near the town of Truth or Consequences, resulting in the deaths of 4 persons in the community of Hillsboro and damage estimated at $1.6 million. About 60 miles farther south, Las Cruces and Deming reported flood damages of $0.7 million and $0.1 million, respectively.

Reservoir storage generally decreased seasonally in the region but remained near or above average in most major reservoirs. Net decline in storage in the Colorado Storage Project was 615,900 acre-feet. In New Mexico, storage increased in all reservoirs and was above average on the upper Pecos River for the first time since July 1970.

Ground-water levels declined in Montana, western Washington, north-central Nevada, and southern California; and rose in eastern Washington, east-central Nevada, and southeastern Utah. Monthend levels were above average in Montana, Washington, north-central and east-central Nevada, and southeastern Utah; and remained about the same in southern California. In southern Idaho, water levels in the Rupert-Minidoka area—representative of the Snake Plain aquifer—were slightly below average; water level in the well near Atomic City was above average. In southern New Mexico, water levels remained below average but in two key wells the levels were higher than in August and higher than a year ago; the one of the wells near Rosewell is representative of wells tapping the principal aquifer, and the other, near Deming, is representative of the water table in the bolson deposits.

ALASKA

Streamflow decreased in the south and southeast but increased over much of the rest of the State. As a result of rains during the period September 9–12, monthly mean flow of Little Susitna River near Palmer, increased into the above-normal range and Power Creek near Cordova peaked at the third highest discharge in 25 years of record. However, streamflow decreased quite rapidly during the latter part of the month as a result of unseasonably cool weather.

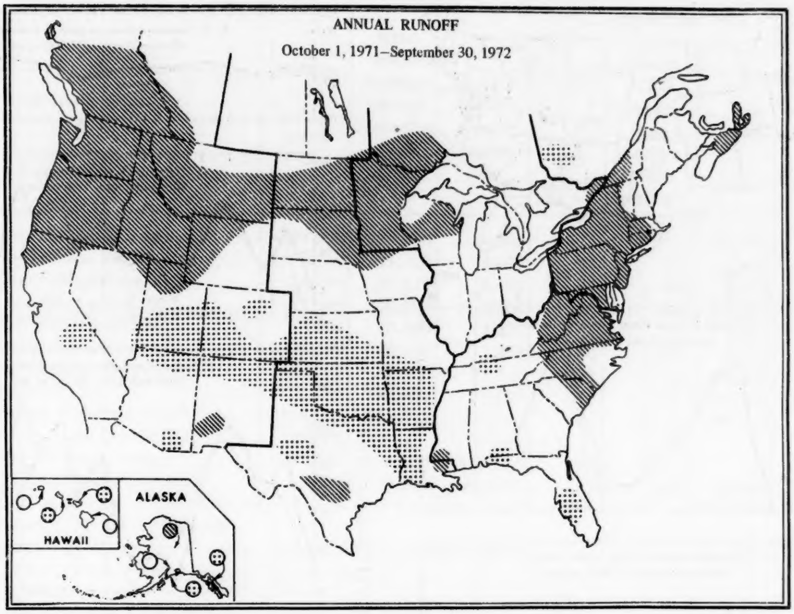
USABLE CONTENTS OF SELECTED RESERVOIRS NEAR END OF SEPTEMBER 1972

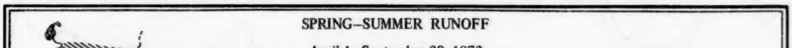
[Contents are expressed in percent of reservoir capacity. The usable storage capacity of each reservoir is shown in the column headed "Normal maximum."]

Reservoir Principal uses: F–Flood control I–Irrigation M–Municipal P–Power R–Recreation W–Industrial	End of Aug. 1972	End of Sept. 1972	End of Sept. 1971	Average for end of Sept.	Normal maximum
	Percent of normal maximum				
NORTHEAST REGION					
NOVA SCOTIA					
Rossignol, Mulgrave, Falls Lake, St. Margaret's Bay, Black, and Ponhook Reservoirs (P)	57	38	52	38	223,400 (a)
QUEBEC					
Gouin (P)	54	57	59	71	6,487,000 ac-ft
Allard (P)	92	81	92	56	280,600 ac-ft
MAINE					
Seven reservoir systems (MP)	84	68	51	55	179,300 mcf
NEW HAMPSHIRE					
Lake Winnipesaukee (PR)	94	78	70	61	7,200 mcf
Lake Francis (FPR)	88	69	83	77	4,326 mcf
First Connecticut Lake (P)	84	76	86	80	3,330 mcf
VERMONT					
Somerset (P)	72	57	75	72	2,500 mcf
Harriman (P)	70	63	75	63	5,060 mcf
MASSACHUSETTS					
Cobble Mountain and Borden Brook (MP)	73	71	77	74	3,394 mcf
NEW YORK					
Great Sacandaga Lake (FPR)	80	64	78	62	34,270 mcf
Indian Lake (FMP)	98	87	74	55	4,500 mcf
New York City reservoir system (MW)	90	77	71	......	547,500 mg
NEW JERSEY					
Wanaque (M)	84	98	96	68	27,730 mg
PENNSYLVANIA					
Wallenpaupack (P)	64	61	60	55	6,875 mcf
Pymatuning (FMR)	98	96	83	79	8,191 mcf
MARYLAND					
Baltimore municipal system (M)	100	100	100	83	85,340 mg
SOUTHEAST REGION					
NORTH CAROLINA					
Bridgewater (Lake James) (P)	90	79	80	81	12,580 mcf
High Rock Lake (P)	77	62	91	64	10,230 mcf
Narrows (Badin Lake) (P)	90	93	93	99	5,616 mcf
SOUTH CAROLINA					
Lake Murray (P)	87	83	84	64	70,300 mcf
Lakes Marion and Moultrie (P)	87	85	68	62	81,100 mcf
SOUTH CAROLINA--GEORGIA					
Clark Hill (FP)	76	68	75	56	75,360 mcf
GEORGIA					
Burton (PR)	87	95	92	77	104,000 ac-ft
Lake Sidney Lanier (FMPR)	57	60	59	54	1,686,000 ac-ft
Sinclair (MPR)	85	86	79	81	214,000 ac-ft
ALABAMA					
Lake Martin (P)	85	69	89	75	1,373,000 ac-ft
TENNESSEE VALLEY					
Clinch Projects: Norris and Melton Hill Lakes (FPR)	54	46	57	36	1,166,000 cfsd
Holston Projects: South Holston, Watauga, Boone, Fort Patrick Henry, and Cherokee Lakes (FPR)	75	63	63	42	1,452,000 cfsd
Douglas Lake (FPR)	55	38	48	32	715,800 cfsd
Hiwassee Projects: Chatuge, Nottely, Hiwassee, Apalachia, Blue Ridge, Ocoee 3, and Parksville Lakes (FPR)	73	62	74	56	523,700 cfsd
Little Tennessee Projects: Nantahala, Thorpe, Fontana, and Chilhowee Lakes (FPR)	80	65	74	56	751,400 cfsd
WESTERN GREAT LAKES REGION					
WISCONSIN					
Chippewa and Flambeau (PR)	98	92	82	72	15,900 mcf
Wisconsin River (21 reservoirs) (PR)	77	89	52	64	17,400 mcf
MINNESOTA					
Mississippi River headwater system (FMR)	40	36	31	32	1,640,000 ac-ft

Reservoir Principal uses: F–Flood control I–Irrigation M–Municipal P–Power R–Recreation W–Industrial	End of Aug. 1972	End of Sept. 1972	End of Sept. 1971	Average for end of Sept.	Normal maximum
	Percent of normal maximum				
MIDCONTINENT REGION					
NORTH DAKOTA					
Lake Sakakawea (Garrison) (FIPR)	98	96	95	......	22,640,000 ac-ft
NEBRASKA					
Lake McConaughy (IP)	77	75	86	64	1,948,000 ac-ft
OKLAHOMA					
Keystone (FPR)	62	80	96	98	661,000 ac-ft
Lake O' The Cherokees (FPR)	86	86	85	81	1,492,000 ac-ft
Tenkiller Ferry (FPR)	87	80	81	85	628,200 ac-ft
Lake Altus (FIMR)	12	9	11	46	134,500 ac-ft
Eufaula (FPR)	70	67	81	77	2,378,000 ac-ft
OKLAHOMA--TEXAS					
Lake Texoma (FMPRW)	79	78	83	92	2,722,000 ac-ft
TEXAS					
Possum Kingdom (IMPRW)	98	95	94	79	724,500 ac-ft
Buchanan (IMPW)	85	82	99	76	955,200 ac-ft
Bridgeport (IMW)	60	53	54	60	270,900 ac-ft
Eagle Mountain (IMW)	91	90	90	86	182,700 ac-ft
Medina Lake (I)	100	99	100	47	254,000 ac-ft
Lake Travis (FIMPRW)	87	83	76	74	1,144,000 ac-ft
Lake Kemp (IMW)	41	45	23	52	461,800 ac-ft
THE WEST					
ALBERTA					
Spray (P)	90	84	80	80	210,000 ac-ft
Lake Minnewanka (P)	96	91	91	86	199,700 ac-ft
St. Mary (I)	60	60	76	65	320,800 ac-ft
WASHINGTON					
Franklin D. Roosevelt Lake (IP)	100	90	94	98	5,232,000 ac-ft
Lake Chelan (PR)	100	92	83	84	676,100 ac-ft
IDAHO--WYOMING					
Upper Snake River (7 reservoirs) (IMP)	77	72	79	47	4,282,000 ac-ft
WYOMING					
Pathfinder, Seminoe, Alcova, Kortes, and Glendo Reservoirs (I)	65	59	66	31	3,016,000 ac-ft
Buffalo Bill (IP)	94	90	87	82	421,300 ac-ft
Boysen (FIP)	93	88	93	82	802,000 ac-ft
Keyhole (F)	90	88	76	34	199,900 ac-ft
COLORADO					
John Martin (FIR)	0	0	0	16	364,400 ac-ft
Colorado–Big Thompson project (I)	77	71	78	55	722,600 ac-ft
Taylor Park (IR)	79	49	79	57	106,000 ac-ft
COLORADO RIVER STORAGE PROJECT					
Lake Powell; Flaming Gorge, Navajo, and Blue Mesa Reservoirs (IFPR)	58	56	58	......	31,276,500 ac-ft
UTAH--IDAHO					
Bear Lake (IPR)	91	86	87	56	1,421,000 ac-ft
CALIFORNIA					
Hetch Hetchy (MP)	70	58	69	57	360,400 ac-ft
Lake Almanor (P)	76	73	86	47	1,036,000 ac-ft
Shasta Lake (FIPR)	76	75	75	67	4,377,000 ac-ft
Millerton Lake (FI)	31	29	30	33	503,200 ac-ft
Pine Flat (FI)	20	21	36	35	1,014,000 ac-ft
Isabella (FIR)	10	9	22	24	551,800 ac-ft
Folsom (FIP)	76	67	69	56	1,000,000 ac-ft
Lake Berryessa (FIMW)	74	72	87	79	1,600,000 ac-ft
Clair Engle Lake (Lewiston) (P)	86	79	86	77	2,438,000 ac-ft
CALIFORNIA--NEVADA					
Lake Tahoe (IPR)	72	65	78	55	744,600 ac-ft
NEVADA					
Rye Patch (I)	88	85	91	43	179,100 ac-ft
ARIZONA--NEVADA					
Lake Mead and Lake Mohave (FIMP)	67	67	66	70	27,970,000 ac-ft
ARIZONA					
San Carlos (IP)	1	5	4	12	948,600 ac-ft
Salt and Verde River system (IMPR)	29	27	33	33	2,073,000 ac-ft
NEW MEXICO					
Conchas (FIR)	47	60	44	79	352,600 ac-ft
Elephant Butte and Caballo (FIPR)	4	7	2	22	2,539,000 ac-ft

[a] Thousands of kilowatt-hours.



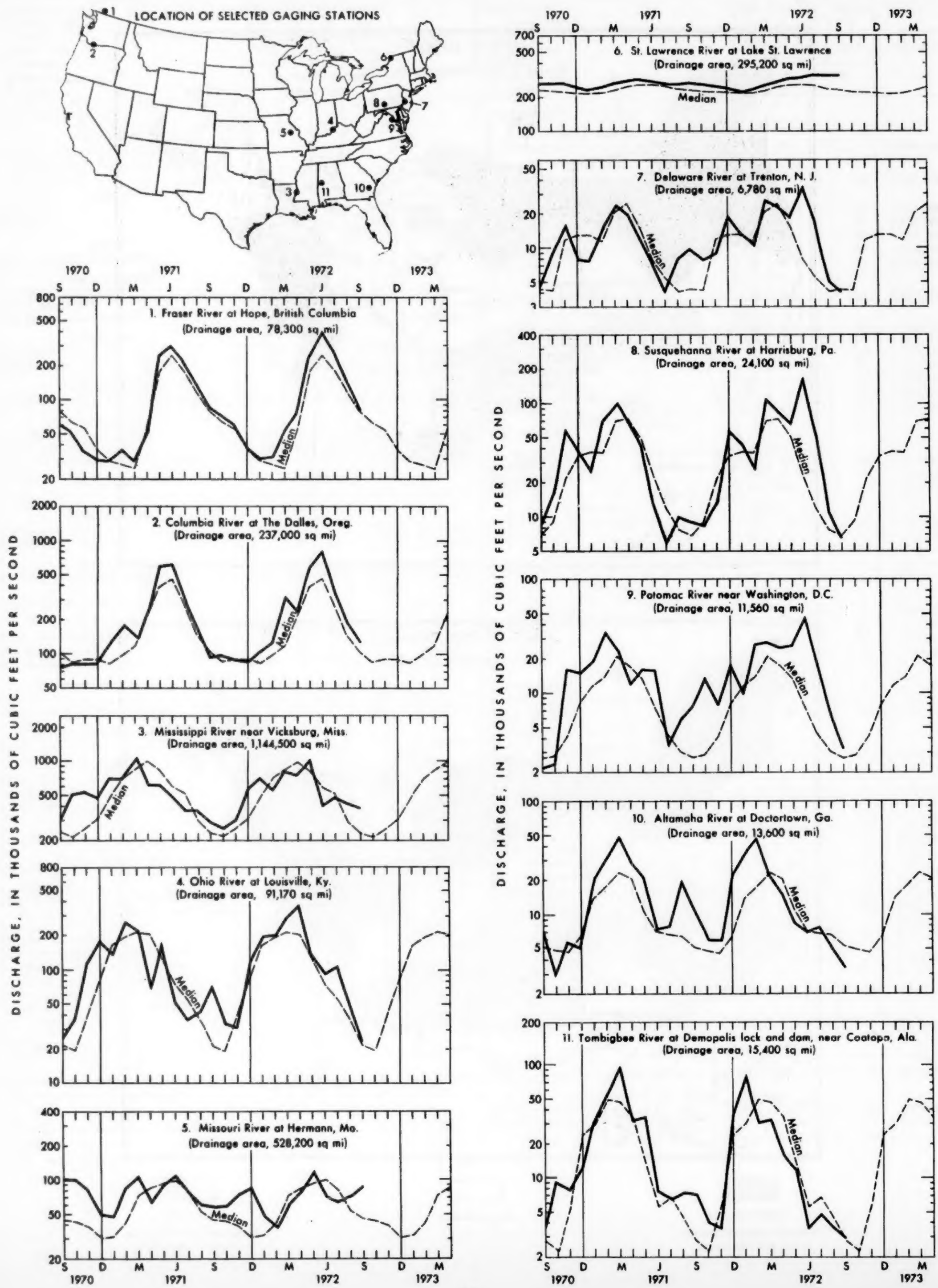


Above normal (within the highest 25 percent of record for this period)

In normal range

Below normal (Within the lowest 25 percent of record for this period)

HYDROGRAPHS OF SOME MAJOR RIVERS, SEPTEMBER 1970 TO SEPTEMBER 1972



Provisional data; subject to revision

FLOW OF MAJOR RIVERS DURING 1972

River and location	Drainage area (square miles)	Mean annual discharge through September 1970 (cfs)	September 1972: Monthly mean discharge (cfs)	Percent of median monthly discharge[1]	Change in discharge from previous month (percent)	Discharge near end of month (cfs)	Discharge near end of month (mgd)	Date
St. Lawrence River at Lake St. Lawrence[2]	295,200	239,100	310,000	135	0	310,000	200,000	30
Delaware River at Trenton, N.J	6,780	11,360	4,039	95	-18	4,100	2,650	30
Susquehanna River at Harrisburg, Pa	24,100	33,670	6,456	94	-42	6,650	4,300	30
Potomac River near Washington, D.C	11,560	10,650	3,260	123	-48	2,700	1,750	30
Altamaha River at Doctortown, Ga	13,600	13,380	3,330	64	-32	3,840	2,480	25
Tombigbee River near Coatopa, Ala[3]	15,400	22,160	2,992	108	-20	2,730	1,760	28
Missouri River at Hermann, Mo	528,200	77,480	85,150	193	+21	76,600	49,600	25
Ohio River at Louisville, Ky[4]	91,170	110,600	23,600	111	-52	14,200	9,180	26
Mississippi River near Vicksburg, Miss[5]	1,144,500	552,700	337,700	146	-20	385,000	249,000	30
Colorado River near Grand Canyon, Ariz	137,800	....	15,670	......	+1	....	....	.....
Columbia River at The Dalles, Oreg[6]	237,000	194,000	129,000	123	-30	....	....	.....
Fraser River at Hope, British Columbia	78,300	95,300	80,000	112	-46	64,800	41,900	28

[1]Reference period 1931–60 or 1941–70.
[2]Records furnished by U.S. Army, Corps of Engineers, Buffalo District. Discharges shown are considered to be the same as those at Ogdensburg, N.Y., which is directly opposite Prescott, Ontario.
[3]At Demopolis lock and dam.
[4]Records furnished by U.S. Army, Corps of Engineers.
[5]Records of daily discharge computed jointly by Corps of Engineers and Geological Survey.
[6]Discharge determined from information furnished by Bureau of Reclamation, Corps of Engineers, and Geological Survey.

WATER RESOURCES REVIEW — SEPTEMBER 1972

Cover map shows generalized pattern of streamflow for September based on 22 index stream-gaging stations in Canada and 130 index stations in the United States. Alaska and Hawaii inset maps show streamflow only at the index gaging stations which are located near the points shown by the arrows.

Streamflow for September 1972 is compared with flow for September in the 30-year reference period 1931–60 or 1941–70. Streamflow is considered to be *below normal* if it is within the range of the low flows that have occurred 25 percent of the time (below the lower quartile) during the reference period. Flow for August is considered to be *above normal* if it is within the range of the high flows that have occurred 25 percent of the time (above the upper quartile).

Flow higher than the lower quartile but lower than the upper quartile is described as being within the *normal range.* In the Water Resources Review *normal flow* is defined as the median of the 30 flows of September during the reference period. The normal (median) has been obtained by ranking those 30 flows in their order of magnitude; the highest flow is number 1, the lowest flow is number 30, and the average of the 15th and 16th highest flows is the normal (median).

The normal is an average (but not an arithmetic average) or middle value; half of the time you would expect the September flows to be below the median and half of the time to be above the median. Shorter reference periods are used for the Alaska index stations because of the limited records available.

Statements about *ground-water levels* refer to conditions near the end of September. Water level in each key observation well is compared with average level for the end of September determined from the entire past record for that well or from a 20-year reference period, 1951–70. *Changes in ground-water levels* unless described otherwise, are from the end of August to the end of September.

The Water Resources Review is published monthly. Special-purpose and summary issues are also published. In the United States, issues of the Review are free on application to the Water Resources Review, U.S. Geological Survey, Washington, D.C. 20242.

This issue was prepared by J.C. Kammerer, H.D. Brice, E.W. Coffay. and L.C. Fleshmon from reports of the field offices, October 6, 1972.

FACTORS CONTRIBUTING TO UNUSUALLY LOW RUNOFF DURING THE PERIOD 1962–68 IN THE CONCHO RIVER BASIN, TEXAS

The accompanying abstract and graph are from the report, *Factors contributing to unusually low runoff during the period 1962–68 in the Concho River Basin, Texas,* by S. P. Sauer, U.S. Geological Survey Water-Supply Paper 1999-L, 48 pages, 1972; prepared in cooperation with the Texas Water Development Board. The report can be purchased for $0.35 from the Superintendent of Documents, Government Printing Office, Washington, D. C. 20242.

ABSTRACT

To determine the reasons for the unusually low runoff in the Concho River basin during the period 1962–68, the physical developments and climatic changes in the basin were identified and related to changes in the regimen of streamflow.

Land use, brush infestation, and land-treatment practices have not caused significant changes in the rainfall-runoff relationship.

The use of surface water for irrigation has increased very little during the past 70 years, and although the use of ground water for irrigation has greatly increased in the past 25 years, springflow has not been significantly diminished. The base flow of the streams is materially reduced by surface-water irrigation diversions. Diversions for municipal and industrial use have increased rapidly, but these diversions affect only the streamflow downstream from San Angelo.

Statistical analyses showed the annual rainfall to be highly variable, with little serial correlation. Records of rainfall during the period 1943–68 are significantly different in character from previous long-term records. The frequency of monthly rainfall equal to or greater than 2.0 inches during the period 1943–68, and especially during the period 1962–68, was significantly less than the long-term averages (fig. 1).

Analyses of annual runoff data, adjusted for depletions, show large variations in annual runoff. Coefficients of variation ranged from 0.8 to 1.4, and first-order serial correlations ranged from 0.01 to 0.28. The estimated recurrence interval of the 1962–68 drought is about 200 years.

The analyses of rainfall-intensity and runoff data indicate that the basic cause for the relatively low runoff during the period 1962–68 was the lack of high-intensity, long-duration storms rather than any physical changes or agricultural proctices in the watershed.

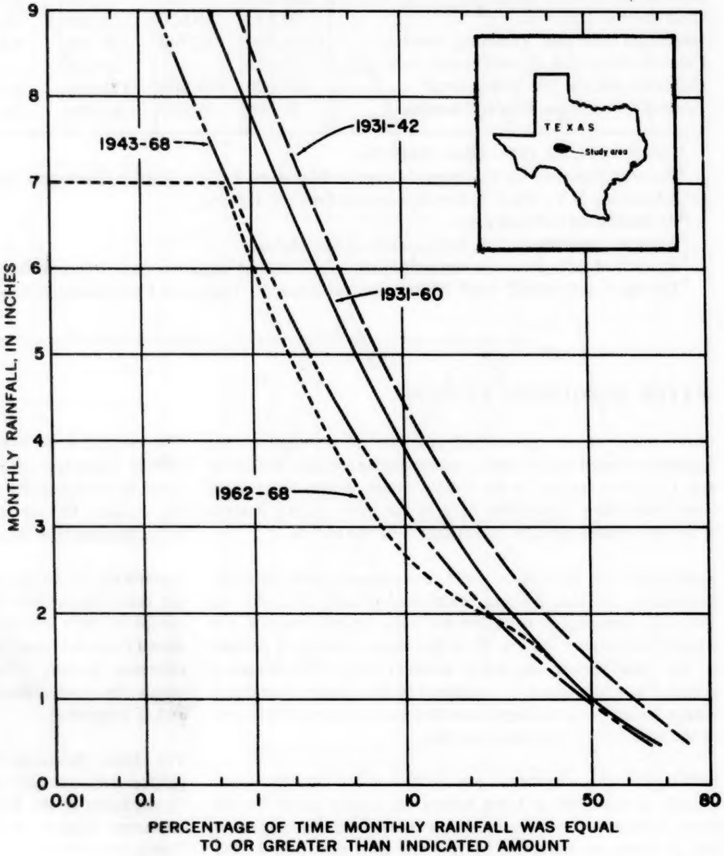


Figure 1.—Frequency distribution of monthly rainfall at San Angelo.

WATER RESOURCES REVIEW